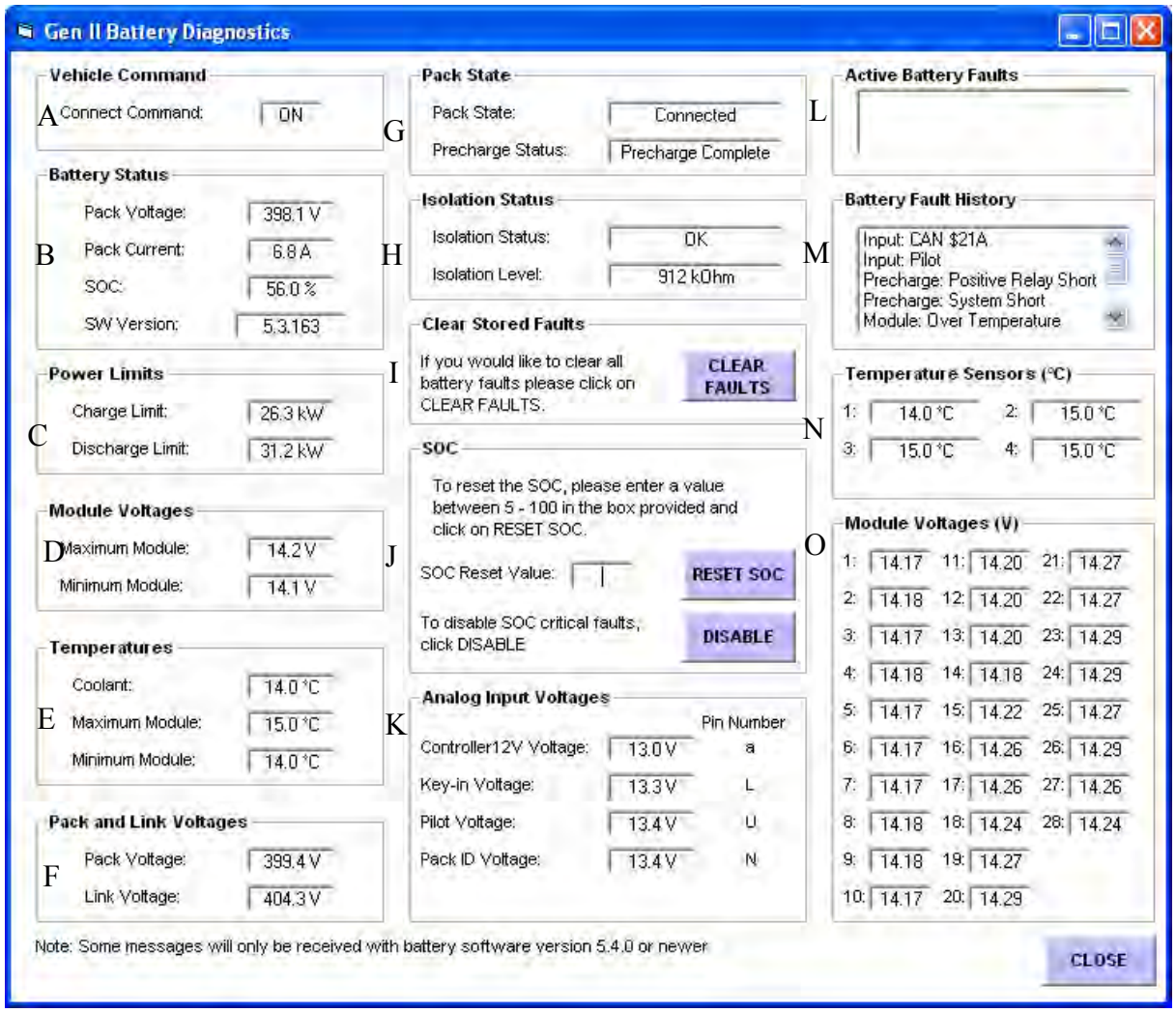
11 Software

11.1 G1 Battery and Vehicle Diagnostic Software

The vehicle diagnostic tool is intended to give visibility into the inputs/outputs and the operating state of the vehicle controller (DICO), the ESS, and provide a method of checking the functionality of the instrument cluster. It communicates with the vehicle over the powertrain CAN bus through connector C024s. The drop-down menus on the home screen allow the user to choose what kind of vehicle they are working on. These selections determine which windows will open when the _Open‘ button is pressed. The check boxes on the centre-right of this screen allow the user to choose which diagnostic windows to display.

11.1.1 ESS Diagnostics Screen

This page displays all the available Gen II battery diagnostics. Some of the displays will not update if the battery software version is not 5.4.0 or newer.

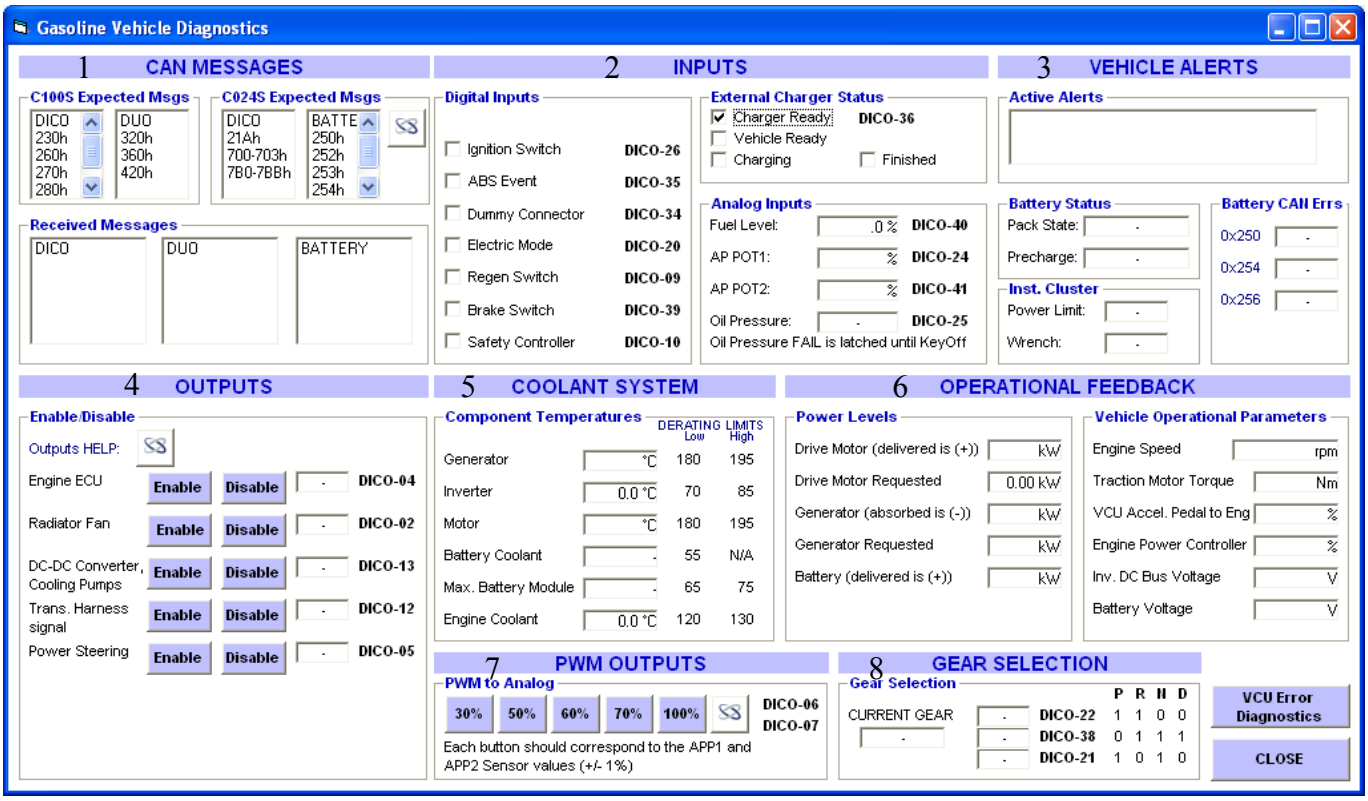


No.	Section	States	Description

A	Vehicle Command	ON/OFF	This is the only bit sent by the DICO to control the battery pack. When the *Connect* command is ON, the battery will precharge the DC bus and remain connected to the DC bus until the *Connect* command is removed (unless there is a critical fault requiring the battery to open contactors on its own).
B	Battery Status		Overall pack operating data: pack voltage, current, SOC and software version. Note that the software version will only show up correctly in SW versions 5.4.0 and newer.
C	Power Limits		These are limits sent by the pack indicating how much charge and discharge are allowed – this calculated by algorithms based on voltage levels, life expectancy and module voltage delta prevention.
D	Module Voltages		The maximum and minimum cell module voltages. If there is an imbalance in the module voltages, it can be spotted quickly here.
E	Temperatures		The maximum and minimum cell temperatures along with coolant temperature are listed.
F	Pack and Link Voltages		The pack voltage is measured internal to the pack, while the link voltage is measured external to the contactors – i.e. it is a measurement of the voltage on the vehicle DC bus.
G	Pack State	Unavailable Idle Disconnected Precharging Connected Alert Forced Disconnect Sleep	Pack state indicates the current pack status. The most frequent states used are: Disconnected – neither contactor is closed, no electrical connection to vehicle DC bus Precharging – pack is precharging the vehicle‘s DC bus, one main contactor and the precharge contactor are closed Connected – both main contactors are closed, pack is electrically connected to vehicle DC bus. Alert – there is an active fault in the battery pack Forced Disconnect – due to a critical active fault, the battery will open contactors
H	Isolation Status	OK Alert Not Measured	The battery pack performs a check on the resistance level between either DC terminal and the chassis ground. The resistance value measured is indicated along with a state indicating whether a fault was found. The reporting of this value is heavily filtered.
I	Clear Stored Faults		This button allows the fault history (item *M*) to be cleared.

J	SOC		This function allows you to re-set the SOC of the pack and to disable critical faults (for the key-cycle). There is a lockout mechanism in the battery software that will force a critical fault if the SOC is less than 5% and not allow precharge. This can be worked around with this function allowing the vehicle the chance to charge the battery.
K	Analog Input Voltages		The measured voltages on the LV input pins to the connector. Allows for easy diagnosis of 12V power/ ground supply to the pack.
L	Active Battery Faults	Miscellaneous Fault Critical Fault Module Fault Precharge Fault Input Fault	This buffer displays the current faults in the pack. These fault types are categorical; the specific fault is given in the stored history.
M	Battery Fault History	See battery diagnostics definition.	This buffer displays all the stored faults. This buffer will keep accumulating fault information until it is cleared by a service tool.
N	Temperature Sensors		All the module temperature sensors are displayed.
O	Module Voltages		All the module voltages are displayed.

11.1.2 Vehicle Diagnostics Screen



1. CAN Messages

This screen gives visibility to the CAN message IDs active on the CAN bus. The tool can be plugged into either the powertrain CAN bus (C024S) or the Drive CAN bus (C100S) to monitor CAN messages. The expected messages from the DICO, DUO inverter and battery pack are shown on the top. If these messages are not present, it indicates that there is a potential issue with power supply, grounding, or communication with this component. Note that it is not necessary to check that ALL messages are present from a given component, just enough to ensure that the component is ‗live'.

2. Inputs

This display allows the user to check that various inputs are functional.

Input	Description
Ignition Switch	This input reads the key-start request from the ignition.
ABS Event	Input senses whether the ABS is active on the vehicle. An active ABS signal causes the vehicle to turn off regenerative braking.
Dummy Connector	Input senses whether the dummy connector is connected. This connector is used as a vehicle lockout mechanism – if this connector is not in place the vehicle will not go into HV mode.
Electric Mode	Momentary switch input which requests EV mode. EV mode may be disallowed due to low SOC (<40%) or due to the minimum hybrid mode time requirement (30s).
Regen Switch	Momentary switch input which requests regen to be disabled. Again this request may be ignored due to a minimum time requirement for regen to be enabled (30s).
Brake Switch	Brake switch input from brake pedal.
Safety Controller	The safety controller is a wired signal between the DICO and DUO inverter. It is controlled by the VCU to turn-off the power phase of the inverter in case there is a serious fault in the system. Faults that activate the safety controller will be recorded in the VCU error diagnostics. During key-on the signal will be low initially; it will then cycle low/high (handshake with the DUO) and then stay high while in HV mode. If there is a serious system fault, this signal will be low. Alternatively if the there is a problem with the integrity of the safety controller line, this signal will be low.
Charger Ready	This signal sent from an external charger indicates that the charger is ready.
Vehicle Ready	Internal variable indicating vehicle in Park position, dummy connector ON and charger ON signal – all the conditions to enable external charger operation.
Charging	Internal software variable that indicates contactors are closed and charging demand is requested (PWM signal to charger).
Finished	Internal software variable that indicates that external charging has been terminated. Potential reasons for exiting out of the charging status: 1. Loss of charger ready signal – even a momentary signal blip will stop charging. 2. Max module temperature > 50˚C. 3. (Max – min module voltage) > 1V (DICO parameter ID 54) 4. Min module voltage dV/dt < 0 for > 500ms 5. Pack voltage > (420V – 0.61(V/˚C) x max module temp)
Fuel Level	Gasoline / Diesel fuel tank fill level.
AP POT1	Accelerator pedal potentiometer 1 (Gasoline only).
AP POT2	Accelerator pedal potentiometer 2 (Gasoline only). If there is an issue with either of the two accelerator pedal tracks, a critical fault will be flagged and drive will not be allowed. The diesel vehicle AP has a single channel along with a low idle switch.
Oil Pressure	Oil pressure signal (PASS/FAIL). If one failed measurement is recorded, this fault will be latched until key-off.

3. Vehicle Alerts

Under the *vehicle alerts* section, there is an *active alert* buffer indicating system faults that are currently active. The table below lists all the fault states.

Code	Description
Accelerator pedal correlation error	There is a short to ground or power on one or both accelerator pedal tracks or the tracks do not correlate.
Loss of ECU CAN	Diesel vehicles only. VCU not receiving CAN data from the engine ECU.
Motor or Generator performance reduction	Over temperature or other fault condition exists in motor or generator, components are power limited. Check temperatures, error diagnostics.
Power limit	The power limit lamp on the IC is ON. The vehicle max power has been reduced to 85kW (from 110kW). Solid: Potential causes: ESS power limits < 10kW (hyst = 5kw). ESS pack state in *Alert* mode (current fault state). Low fuel (<5%). Low oil pressure (latched for key-cycle). Powertrain temperature gauge = 100%. Engine has overheated since last key-cycle (130°C Gasoline, 120°C Diesel). Flash: Vehicle is in *LimpHome Mode.* Potential causes: ESS pack failed to precharge or loss of CAN or serious fault requiring energy storage pack to open contactors.
Engine run failure	Engine failure while running. If code appears frequently, check engine error diagnostics.
Engine start failure	Engine failure after start. If code appears frequently, check engine error diagnostics.
System failure	There has been a system failure, consult error diagnostics.
Under voltage	The inverter DC bus voltage is lower than the reference value. This failure will always appear when the vehicle is not in high voltage mode.
Over voltage	The inverter DC bus voltage has exceeded the maximum limit. Check error diagnostics.
System over temperature	One of the components has exceeded maximum temperature. Refer to the powertrain temperature section in the *Instrument Cluster Warning Lights* chapter.
Battery non-critical fault	Potential causes: ESS power limits < 10kW (hyst = 5kw). ESS pack state in *Alert* mode (current fault state).
Battery failure fault	Battery failure fault – ESS pack failed to precharge or loss of CAN or large module voltage delta (>3V) or serious fault requiring energy storage pack to open contactors.
Generator fault	Generator fault, consult error diagnostics.
Motor fault	Motor fault, consult error diagnostics.

The *battery status* section indicates the pack state and precharge status. These are the same status flags as listed in the ESS diagnostics page, but placed here for convenience. The different states are described in the previous section.

Also indicated in this section is the instrument cluster *power limit* and *service lamp* flags. The reasons why these lights come on can be found in the instrument cluster lamp definition section.

Beside the *battery status* section is the *battery CAN errors*. These fault flags indicate if the VCU has flagged a watchdog fault with battery message ID 250, 254 or 256h. The watchdog flags are set if there are no messages received within a 2 second period. This requires 20 consecutive missed messages for ID 250 and 256 (100ms period), and 10 missed messages for ID 254 (200ms period).

4. Outputs

This section allows the user to manually control selected digital outputs from the VCU. This section should be used for the troubleshooting of a component or system, where it is necessary to send the enable signal to verify functionality. To use this section, one must use Siadis to set the VCU parameter 399 – *SIA_Selector* bit 6 equal to 1. This can be done by flashing a special file normally used for commissioning purposes only, or re-setting that parameter by itself. Once this parameter is set, control of the VCU messages is done by external CAN request, and normal vehicle functionality is disallowed – i.e. the vehicle will not go into HV mode with this parameter set.

5. Cooling System

The temperatures from many of the powertrain components are listed here. More details on the de-rating temperatures can be found in the *instrument cluster warning lights* section of this manual. The battery coolant temperature is the only coolant temperature sensor in the system, the rest are component temperature sensors. Note that there are two temperature sensors in the motor, generator, and several in the inverter. If an issue is suspected with a temperature sensor in one of these components, it will most likely not be indicated here, but can be viewed with *Siadis*. Refer to the *Siadis error diagnostics* section for more details.

6. Operational Feedback

In the *power levels* section, the drive motor and generator target (or reference) values are listed along with the actual values. Also listed is the battery power supplied.

In the vehicle operational parameters section, the engine speed, drive motor torque, inverter DC bus voltage, and battery voltage are displayed. Also the accelerator pedal command sent from the VCU to the engine is shown, (idle = 13.12%, full throttle = 50.35%) with the engine power controller. The power controller adjusts the feed-forward demand (i.e. throttle demand mapped versus engine speed) based on feedback of the actual power output of the genset.

7. PWM Outputs

The VCU sends two PWM output channels to the PWM to Analog unit which converts them to analog signals that communicate an accelerator pedal input to the engine (TAC module). This section allows for control of these PWM outputs to test the functionality of the PWM to Analog and TAC module. Using the

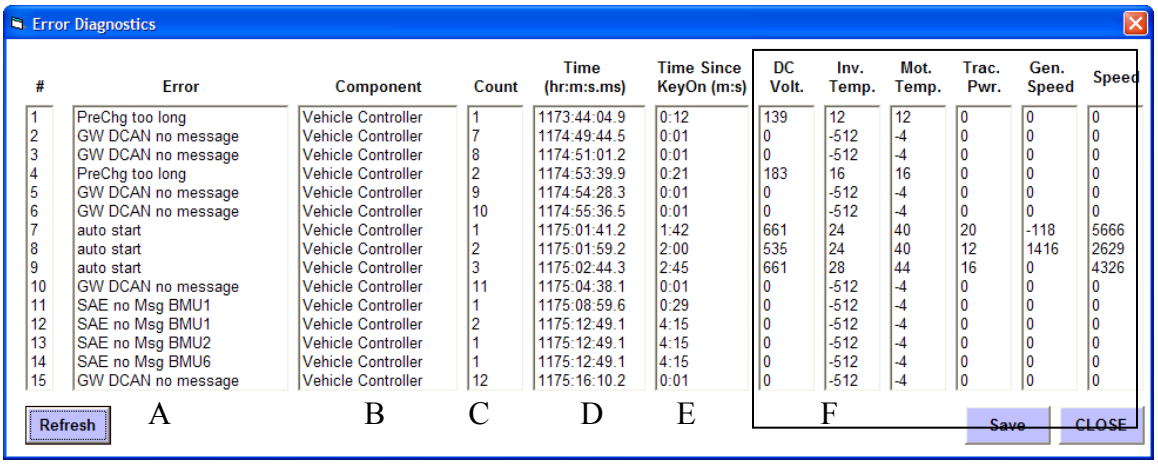
Tech II (or a similar engine diagnostic tool) one can monitor the simulated input channels (typically grouped under TAC module data). The control of the outputs with these buttons needs to be enabled via calibration, similar to the digital output section.

8. Gear Selection

The gear selection section indicates the current gear reading along with all gear selector sensor inputs. The logic for the different gear positions is also shown for reference.

VCU Error Diagnostics

The button in the bottom right corner of the vehicle diagnostics screen allows the user to view the VCU‘s error diagnostics. The newest diagnostic codes are placed at the bottom of the buffer.

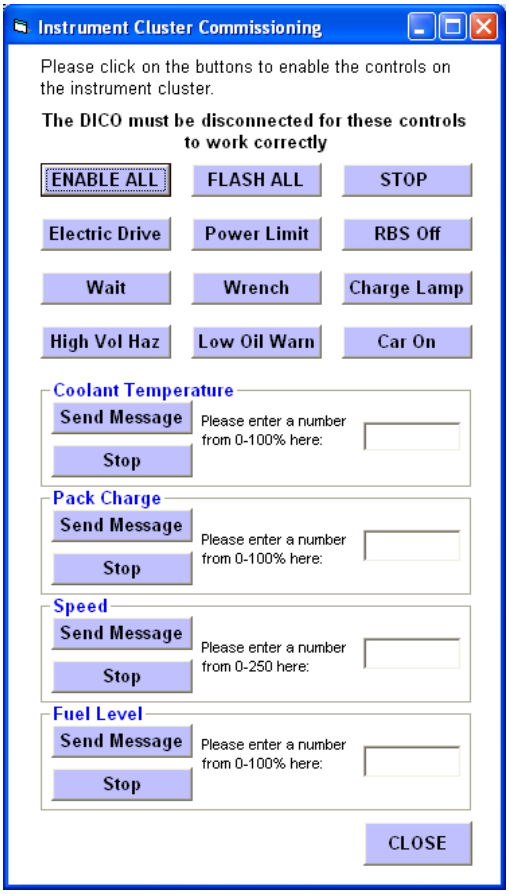

Error Diagnostics
Error Component Count Time (hr:m:s.ms) Time Since KeyOn (m:s) DC Volt. Inv. Temp. Mot. Temp. Trac. Pwr. Gen. Speed Speed
1 PreChg too long Vehicle Controller 1 1173:44:04.9 0:12 139 12 12 0 0 0
2 GW DCAN no message Vehicle Controller 7 1174:49:44.5 0:01 0 -512 -4 0 0 0
3 GW DCAN no message Vehicle Controller 8 1174:51:01.2 0:01 0 -512 -4 0 0 0
4 PreChg too long Vehicle Controller 2 1174:53:39.9 0:21 183 16 16 0 0 0
5 GW DCAN no message Vehicle Controller 9 1174:54:28.3 0:01 0 -512 -4 0 0 0
6 GW DCAN no message Vehicle Controller 10 1174:55:36.5 0:01 0 -512 -4 0 0 0
7 auto start Vehicle Controller 1 1175:01:41.2 1:42 661 24 40 20 -118 5666
8 auto start Vehicle Controller 2 1175:01:59.2 2:00 535 24 40 12 1416 2629
9 auto start Vehicle Controller 3 1175:02:44.3 2:45 661 28 44 16 0 4326
10 GW DCAN no message Vehicle Controller 11 1175:04:38.1 0:01 0 -512 -4 0 0 0
11 SAE no Msg BMU1 Vehicle Controller 1 1175:08:59.6 0:29 0 -512 -4 0 0 0
12 SAE no Msg BMU1 Vehicle Controller 2 1175:12:49.1 4:15 0 -512 -4 0 0 0
13 SAE no Msg BMU2 Vehicle Controller 1 1175:12:49.1 4:15 0 -512 -4 0 0 0
14 SAE no Msg BMU6 Vehicle Controller 1 1175:12:49.1 4:15 0 -512 -4 0 0 0
15 GW DCAN no message Vehicle Controller 12 1175:16:10.2 0:01 0 -512 -4 0 0 0
Refresh
A
B
C
D
E
F
Save
CLOSE

A. Diagnostic Error message – consult the *Siadis Error Diagnostics* section of this manual for troubleshooting instructions related to diagnostic code.
B. Component – this is the controller in which the error has occurred – vehicle controller (DICO), generator or motor (both motor and generator controller internal to the DUO inverter).
C. Count – this is the number of times the error has occurred in this buffer. The buffer is a first in, first out design, however if the newest code already exists in the buffer, the oldest identical code will be deleted, and the new code will have its count incremented.
D. Time – the VCU has an internal clock which counts the number of hours since the controller was initialized. The _time‘ at which the error is recorded is shown in this column, and can be compared against the current controller _time‘, viewable with Siadis (top right corner of screen).
E. Time Since Key-on – this is the elapsed time since key-on at which the error was recorded. This data is useful for determining when the error occurred in the drive cycle. The maximum time possible is 4:15 after key-on, and any error occurred after this time is recorded as 4:15.
F. Operational Data at Time of Error – this is a snapshot of the vehicle operational data at the time the error occurred.

11.1.3 Instrument Cluster Diagnostics Page

This screen allows the user to send commands to the instrument cluster to visually verify that all the lights and gauges are functioning correctly. Note that the DICO needs to be unplugged for this to work correctly; otherwise the lights and gauges will receive conflicting messages and the feedback will not be accurate.

The buttons towards the top of the page control the lights, and the gauges are controlled by entering a number in the appropriate box and then clicking the appropriate _Send Message‘ button. Note that the values that can be entered into the boxes are restricted to those within the range given to the left of the box.

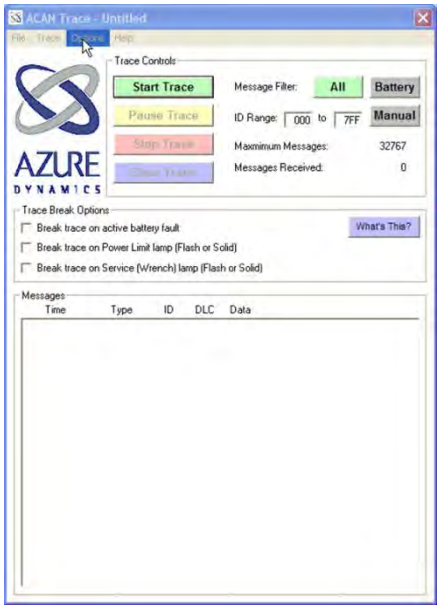


11.1.4

ACAN Trace

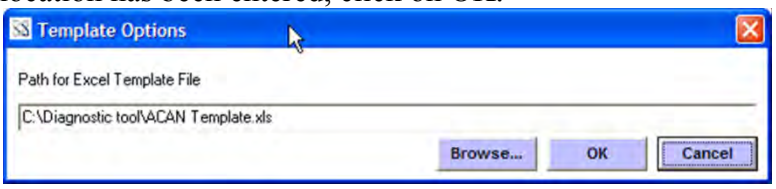
To record a trace of the system operation, click on Run ACAN-Trace. This will start the ACAN Program.

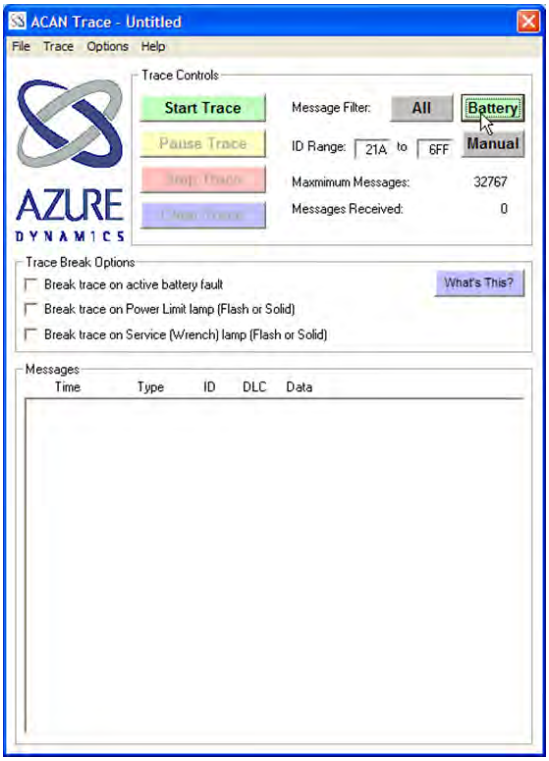
ACAN-Trace Window



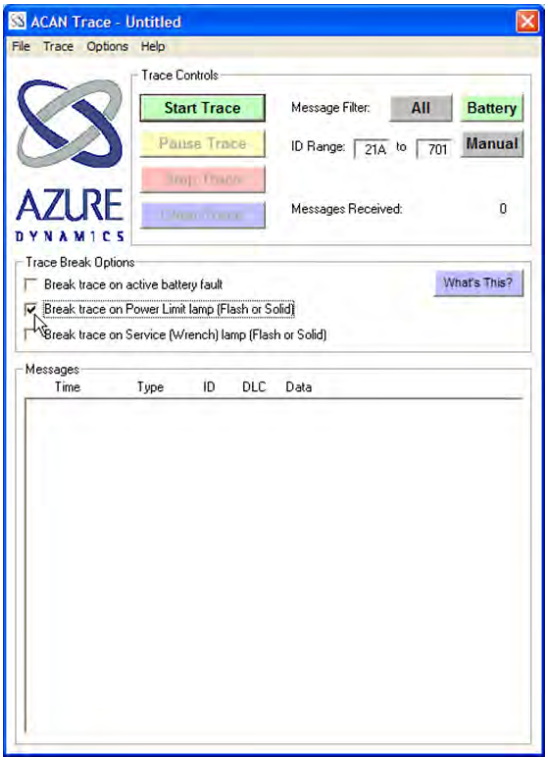
Set File Location

The first time ACAN-Trace is run, it will be necessary to set the file location. Click on options and then either type in the path to the ACAN template or click on browse to search for the file. When the file location has been entered, click on OK.





Select the data that you want to record. Selecting –All" will record all the CAN data, –Battery" will record all the battery messages, or –Manual" allows the selection of a range of messages.

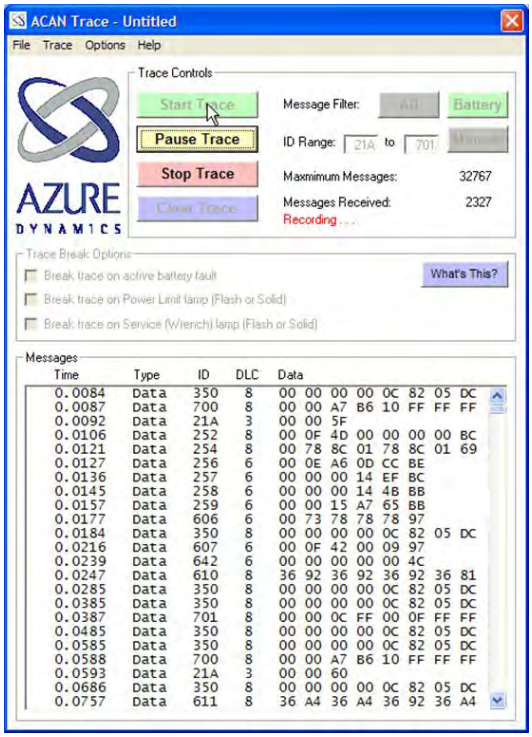


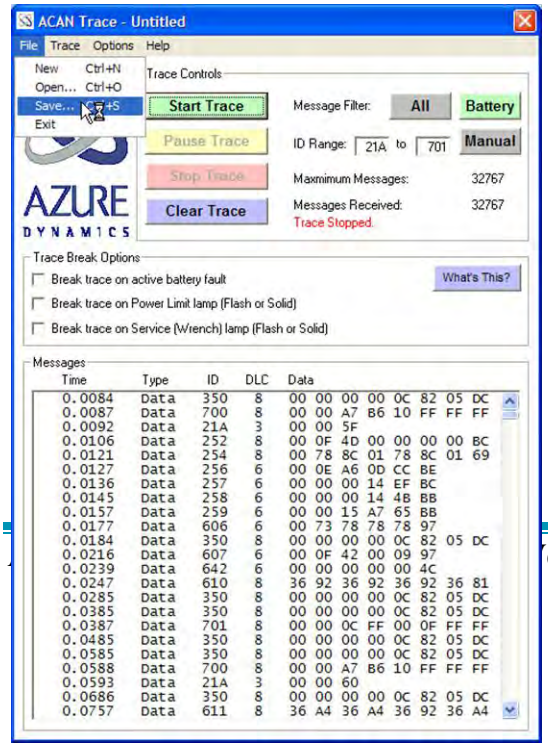
Select the Break options if required. If break options are selected, data will not appear in the window until the trigger of one of the selected options is met. More than one option may be selected. When the trace is started, data will be recorded until the buffers are filled. Once the buffer is full, the oldest data will be written over with the newer data. When the trigger conditions occur, the data will be saved with the trigger placed in the middle of the file.

ACAN Trace - Untitled
File Trace Options Help
Trace Controls
Start Trace
Pause Trace
Stop Trace
Clear Trace
Message Filter:
All
Battery
ID Range:
21A
to
701
Messages Received:
7776
Recording . . .
AZURE DYNAMICS
Trace Break Options
Break trace on active battery fault
Break trace on Power Limit lamp (Flash or Solid)
Break trace on Service (Wrench) lamp (Flash or Solid)
What's This?
Messages
Time
Type
ID
DLC
Data
If any of the "Break trace on . . . " options are selected, recorded messages will only be displayed once the trace is stopped.
If the trace is stopped due to a break condition, this window will show an equal number of messages from before and after the message in which the error was first detected.
If the trace is stopped manually, this window will show the 32 767 most recent messages.

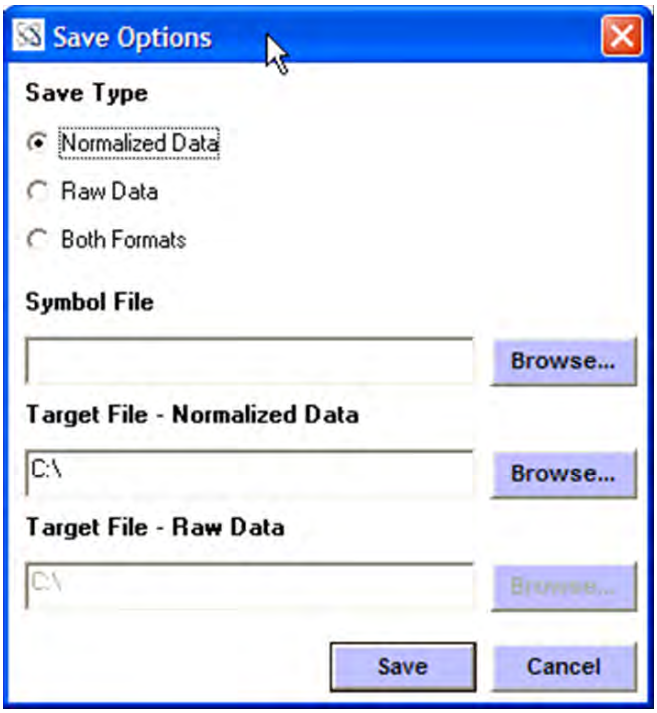
When the trace is started, data will be recorded but not displayed until an event triggers the program. Once the trigger occurs, data before and after the trigger is saved until the buffer is filled. At that point, the raw data will be displayed in the window.

If no trigger is selected, the data will be displayed and will scroll up until the trace is paused, stopped, or the buffer if full. Once recording has stopped, the data can be saved.

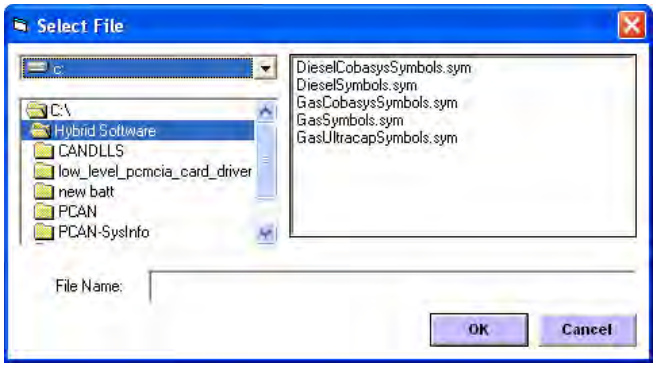

ACAN Trace - Untitled
File Trace Options Help
Trace Controls
Start Trace
Pause Trace
Stop Trace
Clear Trace
Message Filter:
All
Battery
ID Range: 21A to 701
Maxmimum Messages: 32767
Messages Received: 2327
Recording . . .
Trace Break Options
What's This?
Break trace on active battery fault
Break trace on Power Limit lamp (Flash or Solid)
Break trace on Service (Wrench) lamp (Flash or Solid)
Messages
Time Type ID DLC Data
0.0084 Data 350 8 00 00 00 00 0C 82 05 DC
0.0087 Data 700 8 00 00 A7 B6 10 FF FF FF
0.0092 Data 21A 3 00 00 5F
0.0106 Data 252 8 00 0F 4D 00 00 00 00 BC
0.0121 Data 254 8 00 78 8C 01 78 8C 01 69
0.0127 Data 256 6 00 0E A6 0D CC BE
0.0136 Data 257 6 00 00 00 14 EF BC
0.0145 Data 258 6 00 00 00 14 4B BB
0.0157 Data 259 6 00 00 15 A7 65 BB
0.0177 Data 606 6 00 73 78 78 78 97
0.0184 Data 350 8 00 00 00 00 0C 82 05 DC
0.0216 Data 607 6 00 0F 42 00 09 97
0.0239 Data 642 6 00 00 00 00 00 4C
0.0247 Data 610 8 36 92 36 92 36 92 36 81
0.0285 Data 350 8 00 00 00 00 0C 82 05 DC
0.0385 Data 350 8 00 00 00 00 0C 82 05 DC
0.0387 Data 701 8 00 00 0C FF 00 0F FF FF
0.0485 Data 350 8 00 00 00 00 0C 82 05 DC
0.0585 Data 350 8 00 00 00 00 0C 82 05 DC
0.0588 Data 700 8 00 00 A7 B6 10 FF FF FF
0.0593 Data 21A 3 00 00 60
0.0686 Data 350 8 00 00 00 00 0C 82 05 DC
0.0757 Data 611 8 36 A4 36 A4 36 92 36 A4


ACAN Trace - Untitled
File Trace Options Help
New Ctrl+N
Open... Ctrl+O
Save... Ctrl+S
Exit
Trace Controls
Start Trace
Pause Trace
Stop Trace
Clear Trace
Message Filter: All Battery
ID Range: 21A to 701 Manual
Maxmimum Messages: 32767
Messages Received: 32767
Trace Stopped.
Trace Break Options
What's This?
Break trace on active battery fault
Break trace on Power Limit lamp (Flash or Solid)
Break trace on Service (Wrench) lamp (Flash or Solid)
Messages
Time Type ID DLC Data
0.0084 Data 350 8 00 00 00 00 0C 82 05 DC
0.0087 Data 700 8 00 00 A7 B6 10 FF FF FF
0.0092 Data 21A 3 00 00 5F
0.0106 Data 252 8 00 0F 4D 00 00 00 00 BC
0.0121 Data 254 8 00 78 8C 01 78 8C 01 69
0.0127 Data 256 6 00 0E A6 0D CC BE
0.0136 Data 257 6 00 00 00 14 EF BC
0.0145 Data 258 6 00 00 00 14 4B BB
0.0157 Data 259 6 00 00 15 A7 65 BB
0.0177 Data 606 6 00 73 78 78 78 97
0.0184 Data 350 8 00 00 00 00 0C 82 05 DC
0.0216 Data 607 6 00 0F 42 00 09 97
0.0239 Data 642 6 00 00 00 00 00 4C
0.0247 Data 610 8 36 92 36 92 36 92 36 81
0.0285 Data 350 8 00 00 00 00 0C 82 05 DC
0.0385 Data 350 8 00 00 00 00 0C 82 05 DC
0.0387 Data 701 8 00 00 0C FF 00 0F FF FF
0.0485 Data 350 8 00 00 00 00 0C 82 05 DC
0.0585 Data 350 8 00 00 00 00 0C 82 05 DC
0.0588 Data 700 8 00 00 A7 B6 10 FF FF FF
0.0593 Data 21A 3 00 00 60
0.0686 Data 350 8 00 00 00 00 0C 82 05 DC
0.0757 Data 611 8 36 A4 36 A4 36 92 36 A4

Click on File, Save, and a save option screen will open.

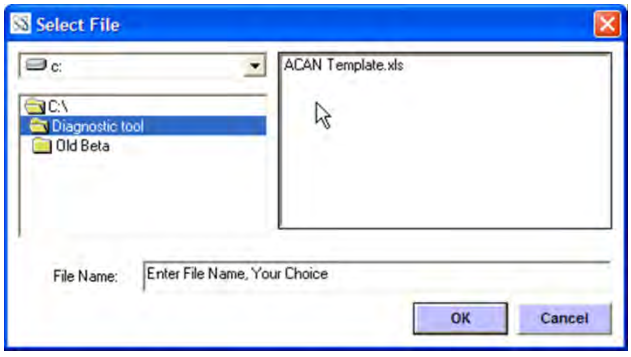


To save the file with the –Normalized Data" option, it is necessary to have MS Excel installed on the computer. Click on Browse and select the proper symbol file to use.

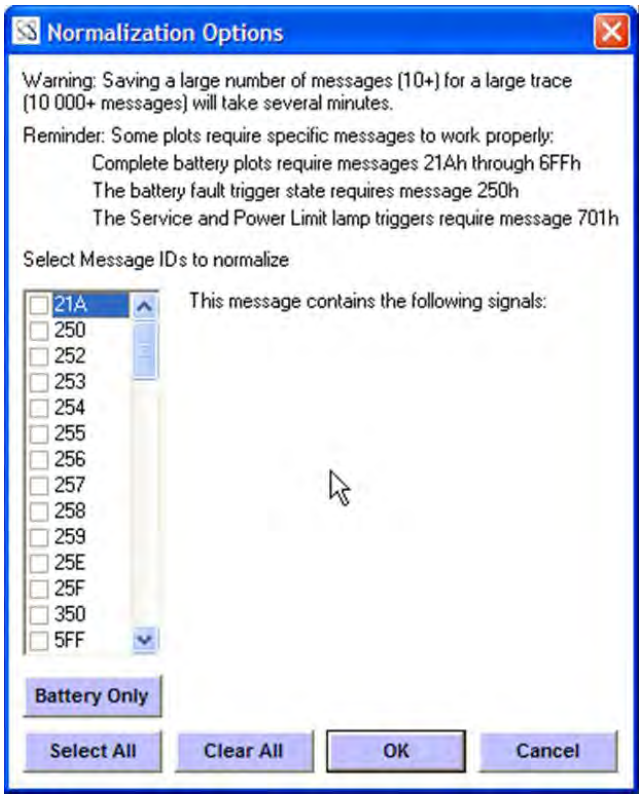


Click on Browse for the –Target File- Normalized Data" and enter a file name to save the data as. This is a name that you chose, normally something related to the vehicle such as a unit number with the date.

For gasoline vehicles, select the GasSymbol.sym file that corresponds to the vehicle Energy Storage System. The file should be located in the same directory as the ACAN-Trace program file. Click on OK.



If –Raw Data" or –Both Formats" is selected, click on Browse for the Target File- Raw Data and enter a file name there as well.
When all required fields are entered, click on Save.
For the Normalization Data, the option of selecting the data to save allows the selection of all messages, battery messages only, or specific messages. Normal selection would be All or Battery Only.
Once the selection has been made, click on OK. It will take a few minutes for the software to save the file in the Normalization Data mode. The file will be saved as the name you created with the extension XLS. This file can be opened with MS Excel. The Raw data file will have an extension TRC and can be opened with Notepad.



This window lists the IDs of all the messages that were received during the trace. Since normalizing and saving the data for all the messages can be quite time consuming, it is possible to only select certain messages for normalization. When a message ID is clicked, all the signals contained in that message are displayed in the middle of the window.

This type of save will also automatically generate some plots if the necessary messages are selected. There is a note at the top of the window that specifies which messages are required to have the data plotted. These plots include a variety of ESS data, as well as the status of the –triggers" that can be used with a continuous trace. The plotting functionality requires an Excel Template file. Specify the location of this file (provided with ACAN Trace), under the Options menu in the main window.

e1606239 .trc - Notepad

File Edit Format View Help

```
;$FILEVERSION=1.1
;$STARTTIME=0.467846643518519
;
;   C:\Hybrid Software\e1606239 .trc
;
;  #, Time (ms), Type, ID, Length, Data
    1)      11.4   Rx         0700  8  00 00 BA E2 7C FF FF FF
    2)      12.3   Rx         021A  3  00 01 D5
    3)      13.4   Rx         07B0  8  00 00 00 00 00 00 00 00
    4)      14.4   Rx         07B1  8  05 FA 0E 8B 06 D4 0E 89
    5)      15.4   Rx         07B2  8  2A 18 00 00 00 00 00 00
    6)      16.4   Rx         07B3  8  00 00 00 00 FF C4 FF C6
    7)      17.4   Rx         07B4  8  30 73 00 00 39 38 FF C2
    8)      18.4   Rx         07B5  8  07 00 08 00 07 00 04 01
    9)      19.4   Rx         07B6  8  3B 20 02 01 84 04 00 0A
   10)      20.4   Rx         07B7  8  00 1E 00 1E 00 32 5D 1D
   11)      21.4   Rx         07B8  8  00 01 08 EF 00 20 80 0A
   12)      22.4   Rx         07B9  8  04 00 08 10 00 00 06 45
   13)      23.4   Rx         07BA  8  00 00 1A 60 00 00 00 00
   14)      23.9   Rx         0254  8  00 7C 7F 08 7A 7F 01 5D
   15)      24.4   Rx         07BB  8  48 00 18 70 41 D0 00 00
   16)      32.4   Rx         0650  6  00 10 E4 09 97 43
   17)      38.9   Rx         0250  8  00 14 03 FA 00 95 82 99
   18)      41.5   Rx         0701  8  0C 00 0C FF 01 1F FF FF
   19)      42.4   Rx         0702  8  15 52 4E 44 20 20 20 20
   20)      44.5   Rx         0703  8  00 00 00 00 00 00 00 00
   21)      54.5   Rx         0600  7  05 FF FF FF EF 2A F8
   22)      54.7   Rx         0601  7  13 FF FF 00 00 2A F8
   23)      56.2   Rx         0616  8  31 EA 31 FC 32 0E 31 38
   24)      61.5   Rx         0700  8  00 00 BA E2 7C FF FF FF
   25)      62.4   Rx         021A  3  00 01 D6
   26)      63.5   Rx         07B0  8  00 00 00 00 00 00 00 00
   27)      64.5   Rx         07B1  8  05 FA 0E 8E 06 D4 0E 8D
   28)      65.5   Rx         07B2  8  2A 18 00 00 00 00 00 00
   29)      66.5   Rx         07B3  8  00 00 00 00 FF C4 FF C9
   30)      67.5   Rx         07B4  8  30 73 00 02 39 18 FF C3
```

ACAN-Trace Sample opened with Notepad

Microsoft Excel - 1606239.xls

File Edit View Insert Format Tools Data Window Help Adobe PDF

A3 Time

Message ID: 250h

Time	PackState	Precharge Status	SOC	BatteryCoolant Temperature	Isolation Status	Battery Fault: Critical	Battery Fault: Input	Battery Fault: Misc	Battery Fault: Module	Battery Fault: Precharge
(s)	0="Unavailable"	0="Precharge Inactive"	(%)	(°C)	0="OK"					
	1="Idle"	1="Precharge Inhibited"			1="Alert"					
	2="Disconnected"	2="Precharging"			3="Not Measured"					
	3="Precharging"	3="Precharge Complete"								
	4="Connected"	4="Precharge Failure"								
	5="Alert"									
	6="Forced Disconnect"									
	7=""									
	8="Sleep"									
0.0389	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
0.1415	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
0.2458	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
0.3487	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
0.452	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
0.5552	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
0.6583	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
0.7643	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
0.8687	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
0.9754	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
1.0784	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
1.1808	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
1.2836	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
1.3868	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
1.489	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
1.5921	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
1.696	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
1.7994	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	
1.9041	4 Connected	3 Precharge Complete	74.5	25	0	0	0	0	0	

Summary 21Ah 250h 252h 253h 254h 255h 256h 257h 258h 259h 25f

Ready Count=14 NUM

ACAN-Trace Sample opened with Excel

11.2 Siadis

For more advance vehicle diagnosis, as well as for flashing calibration files, the Siemens Siadis software tool is used. Siadis can be used to verify code version in the inverters, load new parameters, monitor variables in real-time, log variable traces, and view, save, and clear error diagnostic codes. Siadis uses CAN to communicate with the DUO inverter and the DICO and communicates via the C100s D-sub.

Note: There exists two separate software license files (SiadisExpert.key). One intended for Azure technicians is fully featured, while the other is intended for outside technicians working on the G1 product. This license is limited in that it does not allow the user to change parameters in the DICO or the DUO and does not allow access or the ability clear the error diagnostics in the inverter. However it does allow the users to view all variables, record traces and view/clear error diagnostics in the DICO.

11.2.1 Connecting

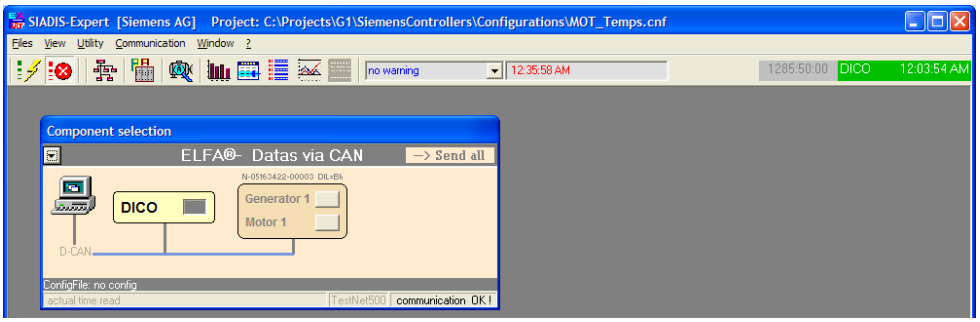
Before starting Siadis, make sure that the CAN Peak-Dongle software is properly installed (contact Azure Dynamics Product Support for latest installation package) and that the CAN Peak-Dongle is connected to the laptop (either through the parallel or PCMCIA ports).

Tip: The parallel port Dongle must to be connected to the laptop when the computer is powered up. If it wasn"t, then Siadismay fail to communicate with the vehicle. If this happens, go to the Start Menu → Control Panel → CAN Hardware. Under the „General" tab in the „Properties of CAN-Hardware" window, press the <Add> button then select „Peak Dongle – CAN SJA EPP"for Hardware Type, „0378" for I/O Address and „7"for Interrupt no. Press <OK> to accept the changes and <OK> again to exit the Properties window.

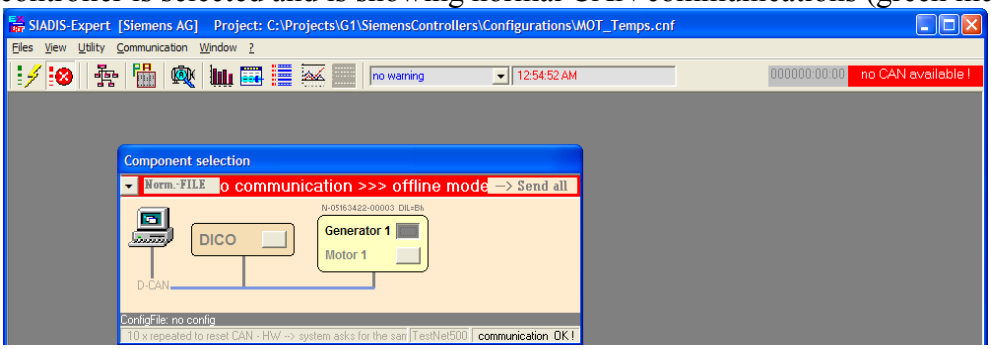
Next, connect the laptop via the dongle to connector C100S on the vehicle using a straight-through serial cable and make sure that the system is powered-up (vehicle is in key-on position). You are now ready to start using Siadis.

11.2.2 Starting the Program and Component Selection

To start the program, double-click on the Siadis icon on the desktop or (if not available) click on the Start menu at the bottom left of the screen then go to All Programs → SiadisExpert → SiadisExpert. The program window will pop up and Siadis will automatically attempt to connect to any components available on the CAN bus (see figure below). To select a component, click on the appropriate box in the Component Selection window in Siadis. All commands and displays will pertain to the selected component until a new component is selected.



Siadis Main Window. In this capture, Siadis has found a DICO, Motor, and Generator Inverter. The DICO controller is selected and is showing normal CAN communications (green indicator at top right corner).



Siadis Main Window. In this capture, the Generator controller is selected but Siadis is showing a loss of CAN communications.

11.2.3 Viewing Data

Select the component you would like to connect to.
Go to the _View' menu and select _Data List'. A new window will pop up.
To choose variables, right-click anywhere in the _Data List' window. This will cause another window titled _Config Data List' to appear showing all available variables.
Select desired variables to view by checking the box next to them and press <OK> when done. The selected variables will now appear in the –Data List' window with their real-time values displayed next to them.

11.2.4 Downloading Parameters

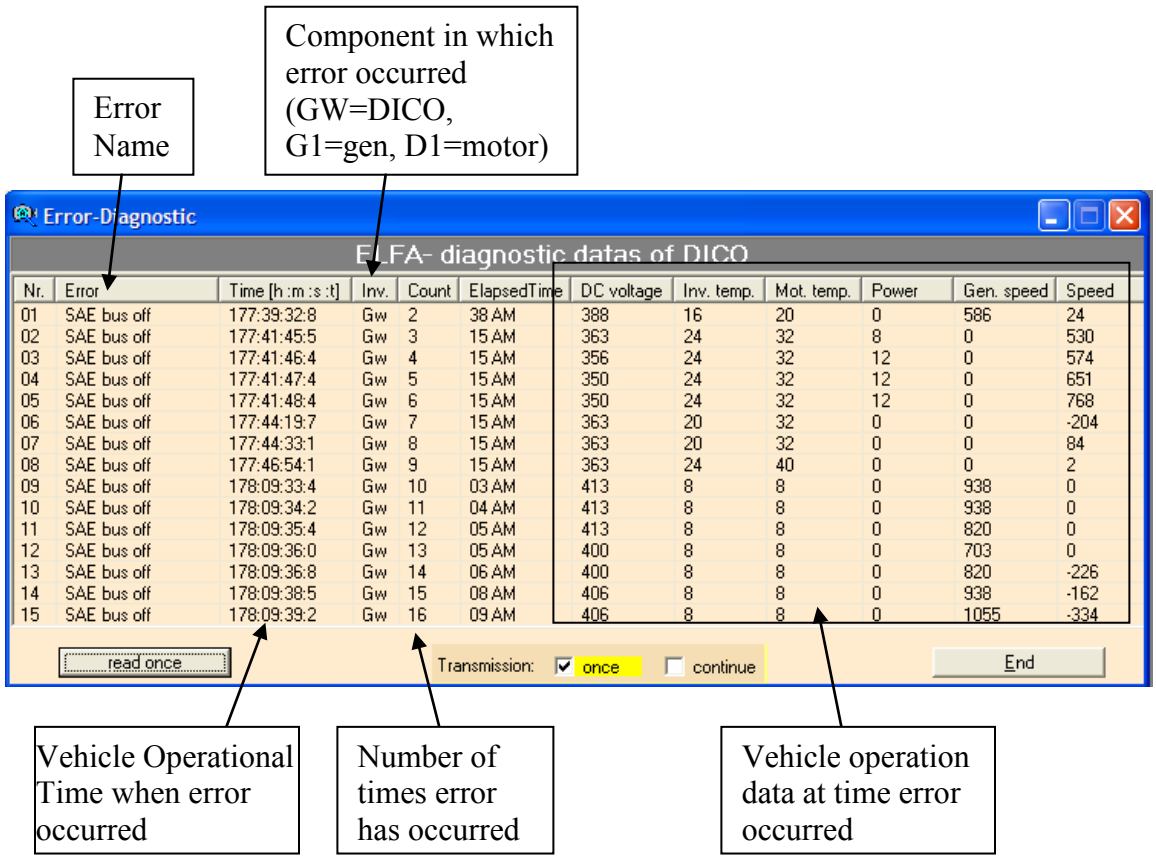
Select the component you would like to download parameters to.
From the _View‘ menu, select _Parameter‘. A new _Parameter‘ window will pop up displaying the current parameters in the inverter with their values.
To download a Parameter file:
In the _File‘ menu, select _Open Parameter‘
Choose the desired parameter file by navigating to its saved location then pressing <Open> in the dialog box. A valid parameter file will have a *.par extension
The new parameter values will now appear under the _Change Buffer‘ section in the Parameter window.
Press the <Download Change Buffer> button at the top of the window. The values of the parameters under the _real parameters‘ heading will now change to the new values, and the parameters under the _Change Buffer‘ section will disappear. At this point the values are only stored in the RAM memory, and will be erased if the power is cycled to the controllers (i.e. if the key is turned off).
Save the new values to permanent memory by going to the _EEPROM‘ menu in the main _Siadis-Expert‘ window and selecting _Prog. EEPROM‘. If programming is successful you will get the message: *eeprom – programming o.k.!*
Press <OK>. You have now successfully downloaded a parameter file.
Repeat process for other components as necessary.
To change individual parameters manually:
After step 2 above, click on the parameter to be changed under the _Real Parameter‘ section of the _Parameter‘ window.
The parameter will now appear in the _edit line‘ section of the window.
Enter the new value either as a binary, hex, or decimal value under the appropriate column.
Accept the changes by pressing <Enter> on the keyboard, or by pressing the <Add to Change Buffer> button. If <Enter> is pressed, the new value will be automatically updated. If <Add to Change Buffer> is used, the new value will be placed in the in the buffer until it is downloaded into the inverter as outlined in step 3(d).
Save the changes permanently by following step 3(e)-(f).
Tip: The Menu tool bar contents change depending on the window you have active, so if you can"tfind a command you are looking for, double check that you are looking at the correct window.

11.2.5 Uploading Parameters

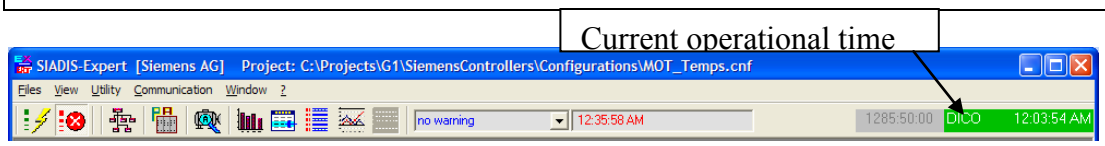
Select the component you would like to upload parameters from.
From the _View‘ menu, select _Parameter‘. A new _Parameter‘ window will pop up displaying the current parameters in the inverter with their values.
In the main _Siadis-Expert‘ window, select _Save Parameter‘ from the _Files‘ menu.
You will now be prompted to enter the file name. Choose an appropriate name and use the default extension (*.par).
Press the <Save> button.
You have now successfully uploaded and saved the parameters from the inverter.
Repeat the steps for the other components as required.

11.2.6 Checking Error Diagnostics

Select the component you would like to view the fault log for.
In the main _Siadis-Expert‘ window, select _Error Diagnostic‘ from the _View‘ menu.
A new _Error Diagnostic‘ window will pop up containing any error codes that have been logged.


Error Name
Component in which error occurred (GW=DICO, G1=gen, D1=motor)
Error-Diagnostic
ELFA- diagnostic datas of DICO
Nr. | Error | Time [h :m :s :t] | Inv. | Count | ElapsedTime | DC voltage | Inv. temp. | Mot. temp. | Power | Gen. speed | Speed
01 | SAE bus off | 177:39:32:8 | Gw | 2 | 38 AM | 388 | 16 | 20 | 0 | 586 | 24
02 | SAE bus off | 177:41:45:5 | Gw | 3 | 15 AM | 363 | 24 | 32 | 8 | 0 | 530
03 | SAE bus off | 177:41:46:4 | Gw | 4 | 15 AM | 356 | 24 | 32 | 12 | 0 | 574
04 | SAE bus off | 177:41:47:4 | Gw | 5 | 15 AM | 350 | 24 | 32 | 12 | 0 | 651
05 | SAE bus off | 177:41:48:4 | Gw | 6 | 15 AM | 350 | 24 | 32 | 12 | 0 | 768
06 | SAE bus off | 177:44:19:7 | Gw | 7 | 15 AM | 363 | 20 | 32 | 0 | 0 | -204
07 | SAE bus off | 177:44:33:1 | Gw | 8 | 15 AM | 363 | 20 | 32 | 0 | 0 | 84
08 | SAE bus off | 177:46:54:1 | Gw | 9 | 15 AM | 363 | 24 | 40 | 0 | 0 | 2
09 | SAE bus off | 178:09:33:4 | Gw | 10 | 03 AM | 413 | 8 | 8 | 0 | 938 | 0
10 | SAE bus off | 178:09:34:2 | Gw | 11 | 04 AM | 413 | 8 | 8 | 0 | 938 | 0
11 | SAE bus off | 178:09:35:4 | Gw | 12 | 05 AM | 413 | 8 | 8 | 0 | 820 | 0
12 | SAE bus off | 178:09:36:0 | Gw | 13 | 05 AM | 400 | 8 | 8 | 0 | 703 | 0
13 | SAE bus off | 178:09:36:8 | Gw | 14 | 06 AM | 400 | 8 | 8 | 0 | 820 | -226
14 | SAE bus off | 178:09:38:5 | Gw | 15 | 08 AM | 406 | 8 | 8 | 0 | 938 | -162
15 | SAE bus off | 178:09:39:2 | Gw | 16 | 09 AM | 406 | 8 | 8 | 0 | 1055 | -334
read once
Transmission: once continue
End
Vehicle Operational Time when error occurred
Number of times error has occurred
Vehicle operation data at time error occurred

Tip: the time at which the error occurred is the total operational time since the controller was first initialized (does not get reset due to software flashing). This can be compared to the current operational time, to determine the time since the error occurred. The current operational time is found in the top right hand corner of the Siadis screen. Note that the operational time will in all likelihood be different for all three controllers in the system.



The last code listed on the error diagnostic screen is the newest code, the top one is the oldest code. If the error diagnostic buffer is full, the oldest code will be overwritten. However if there are repeat codes, then the oldest identical code will be removed, and the count column will be incremented for the new entry.

The DICO controller will store the error diagnostic components for the generator and motor in its error diagnostic buffer as well.

11.2.7 Saving Error Diagnostics

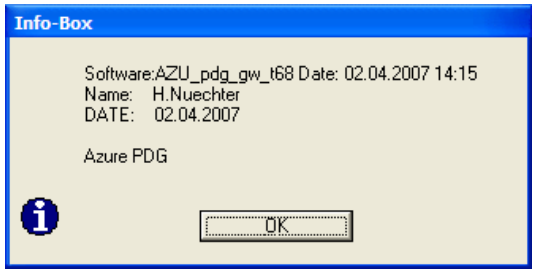
Follow steps outlined in section 5.6 to bring up the Error Diagnostics window
Select _SaveDiagnostic‘ from the _File‘ menu.
Type in an appropriate file name and save with the default extension *.err

11.2.8 Clearing Error Diagnostics

Follow steps outlined in section 5.6 to bring up the Error Diagnostics window
Under the _Error-Buffer‘ menu, select _Delete ErrorBuffer‘.

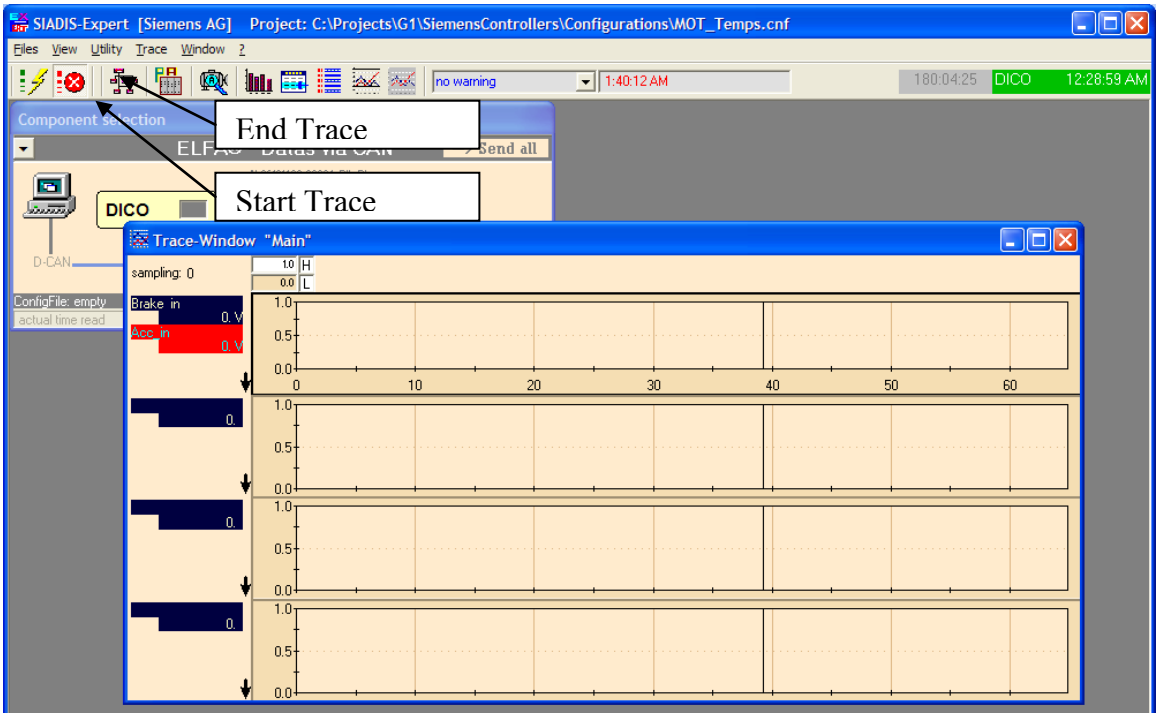
11.2.9 Checking Software Version

In the _Siadis-Expert‘ main window, select the appropriate component.
Under the _Utility‘ menu, select _Software Version‘.
A window showing the version information will pop up. This information can be compared to the software drawing files to determine what version of code is on the controller.



11.2.10 Data Traces

Select the component that contains the variables that need to be logged
From the _View‘ menu, select _Trace Main‘
A new trace window will appear with a default of four graphs showing.
To add a variable to a graph, double-click in the left-hand margin on the colored box next to the graph. A new window will pop up with a list of available variables.
Select the desired variable and press <Ok> to continue.
To add another variable to the same graph, right-click in the left-hand margin next to the graph and choose _Insert Value‘ from the pop-up options. A window containing the available variables will appear.
Select the desired variable and press <Ok>
To start a trace, press the lightning icon in the top left corner of the Siadis window.
To stop the trace, press the stop icon next to the lightning button.
Save the trace by selecting _Save Measure as Decimal‘ from the File‘ menu. Give it an appropriate name and use the default extension (*.med)



11.2.11 Reviewing Data Traces

From the _View‘ menu, select _Trace Main‘.
From the _Files‘ menu, select _New Trace Measurement‘
From the _Files‘ menu, select _Open Measure Decimal‘
Select the previous save *.med file and press <Open>

Tip: As long as the trace was taken in send all mode (selected in the top right corner of the component window), all variables are available for viewing in a saved trace, even if they were not specifically logged during the original trace event.

11.2.12 Setting up Configuration Files

Configuration files can be used to save current Siadis view settings such that variables don‘t have to be re-selected manually for viewing or logging every time Siadis is opened, etc. To set up a configuration file, once you have the desired settings, select _SaveConfig‘ or _Save Config As‘ from the _Files‘ menu. Give the file an appropriate name and use the default configuration extension (*.cnf). To load a previously saved configuration, select _Open Config‘ from the _Files‘ menu.

11.3 Battery Programming Software

11.3.1 Special Tools

1. Laptop or PC
2. Programming Adapter Harness (used if pack is not installed in vehicle) – photo 1. Also available in 12 VDC version
3. CAN Hardware – either Softing CAN-USB - photo 2 or Softing PCMCIA CAN card or Vector PCMCIA CAN card X/XLVector CAN card – photo 3. Note that all 3 CAN hardware options are supported by Cobasys software.

Photo 1. Programming adapter harness – 120 VAC plug-in version shown.

Photo 2. Softing CAN-USB.

Photo 3. Vector PCMCIA CANcard XL.

11.3.2 Required Software Files

- Cobasys Code File Loader Software: "S12Programmer.exe"
- Correct version of Cobasys Code Files: .s19 and .map file
- Cobasys Calibration File Loader Software: "usbsetup.exe"
- Correct version of Cobasys Calibration Files: BattCalParams.prm, RpCalParams.prm, and the correct application-specific file (ex.CalParams_Azure_336_500k.prm or CalParams_Azure_288_500k.prm)
- Corresponding .dll file for the CAN interface:
  - CANusb.dll for Softing USB
  - Vcand32.dll for Vector PCMCIA

NOTE: Unzip all the programming files to the same folder – in particular, the .dll files must be in the same folder as the S12 programmer.exe.

11.3.3 Process Information

A. Check Code Version Label on Battery Pack

Check to see if the label, located at the front of the battery pack on the driver's side, shows the program code file version. If label is present, and if the listed program code file is the most recent version as indicated on the vehicle BOM, then no further programming is required. If version on BOM is different, proceed to reprogram battery pack.

1. **Set up Programming Hardware**
   - If the pack is installed in a vehicle, it can be programmed directly through the vehicle wiring - the vehicle CAN bus:
   - Ensure its low voltage connector is attached to the vehicle wire harness.
   - Connect a serial cable to the 9-pin DSUB connector, C024S, for G1 or connect an Azure diagnostics harness to C073S for P1. Both connector s are located in the cab under the dash.
   - If the pack is not installed in a vehicle, a programming adapter harness is required:
     - Connect the programming harness to the battery pack low voltage connector on the front of the pack - photo 4.
     - Set the programming harness box's switches as follows:
     - CAN Bus terminating switch by CAN connectors should be switched to "TERMINATED"
     - "OFF / ON" switch should be switched to "OFF"
     - "KEY ON / KEY OFF" switch should be switched to "KEY OFF"
     - Power the programming harness by connecting the 120V AC plug (if so equipped) to a wall outlet (some older harnesses may require 12V power from a power supply or battery instead).
     - Connect a serial cable to a 9-pin DSUB connector on the programming adapter box.
   - Connect the other end of the serial cable to the 9-pin DSUB connector on the CAN programming hardware being used (Vector or Softing).
   - Plug the CAN programming hardware into the accompanying laptop (via USB, or insertion of the PCMCIA card as applicable).

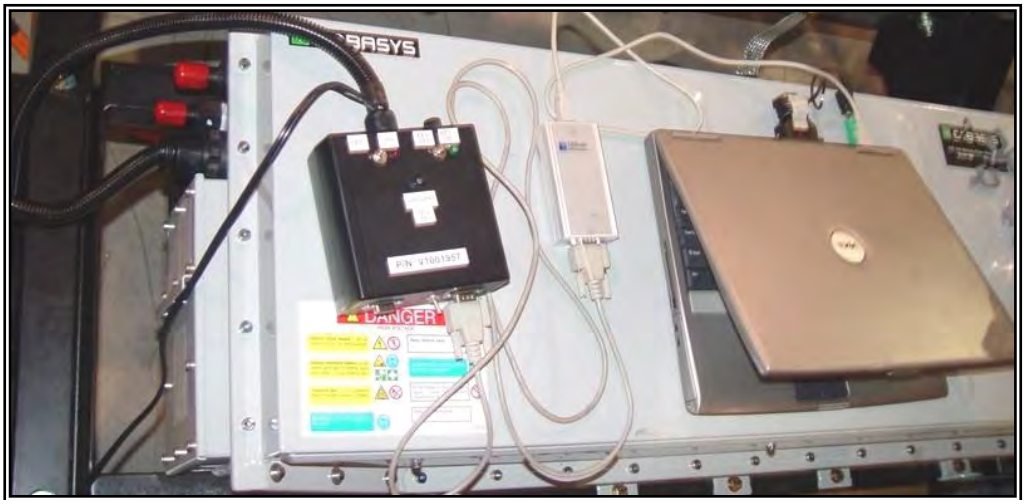


Photo 4. System setup on a pack not installed in a vehicle.

Process Information cont'd

2. Check Program Code Version

- Before programming the pack, please check the software version using an appropriate CAN tool:
- the "Gen II Battery Diagnostics" tool (a subset of the "Vehicle and Battery Diagnostic Tool") with the PCAN hardware
- an alternative manual CAN tool, such as the PCAN or ACAN software with the PCAN hardware, the CANAnalyser software with the IXXAT hardware, or the CANKing software with the KVASER hardware

3. Load Program Code File

- Set-up Program Code File Loader
  - Turn on the PC or laptop.
  - Open the "S12Programmer.exe" programmer software. Figure 12 shows a snapshot of what the programmer will look like.
  - Verify correct Module ID field is selected: zero (0x00).
  - Verify correct controller type is selected: "t_BCM" by "Device Selection->Transportation->BCM" menu.
  - Verify correct CAN interface hardware is selected "CAN Communications" menu.
  - Verify correct CAN channel is selected: (CAN1 or CAN2) "CAN Communications" menu
  - Verify correct CAN speed is selected: (250K or 500K) "CAN Communications" menu: for G1 and P1 vehicles this is "500K".

Figure 49 Programmer

- In the programmer application, click –Load S19”. Note – .s19 and associated .map file must be located in the same directory.
- Select the .s19 file to be loaded in the controller and click –Open”.
- Turn on the pack by either:
- If pack is attached to a vehicle: Turn the vehicle ignition key to the –ON” position. DO NOT enable the high voltage system by turning the ignition to the –START” position e. In the programmer application, click –Program Device”.
- If pack is attached to a programming adapter harness: Set the –OFF/ON” switch to –ON”, then set the –KEY ON / KEY OFF” switch to –KEY ON”
- In the programmer application, click –Program Device”.
- If the pack already has the same software version as the file you are loading, the message in Figure 13 will appear. This means that you do not need to continue flashing, although there is no harm in continuing.
- Wait for programming to complete—the status window will show a message that says, –The module has reset correctly”. Figure 14 shows the programmer when flashing has been successful.
- Turn off the pack with either key off or with programming adapter: Set the –KEY ON / KEY OFF” switch to –KEY OFF”, wait 10 seconds to allow the pack to enter sleep mode, then set the –ON / OFF” switch to –OFF”.

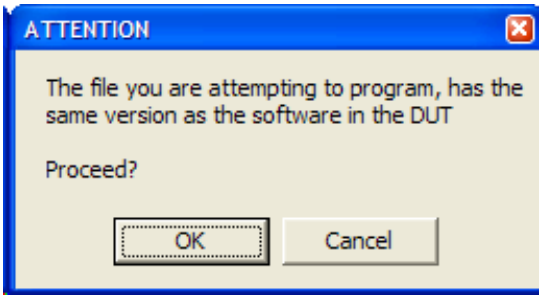


Figure 50

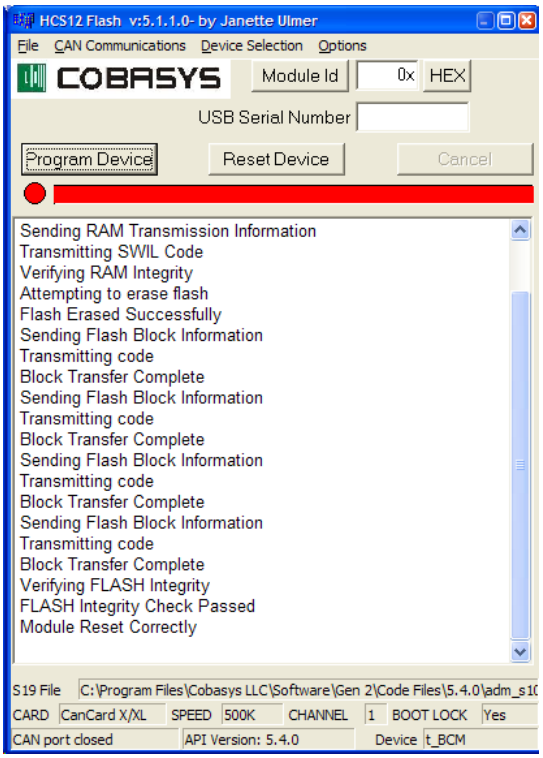


Figure 51

4. **Load Calibration File**
   - Set-up Calibration File Loader
     - Turn on the PC or laptop.
     - Open the –ubcsetup.exe" calibration download software. Figure 15 shows a snapshot of the calibration loader at start-up.
     - Verify correct Module ID field is selected: zero (0x00).
     - Verify correct CAN interface hardware is selected.
     - Verify correct CAN channel is selected: (CAN1 or CAN2)
     - Verify correct CAN speed is selected: (250K or 500K) –CAN
     - Communications" menu: for G1 andP1 vehicles this is –500K".

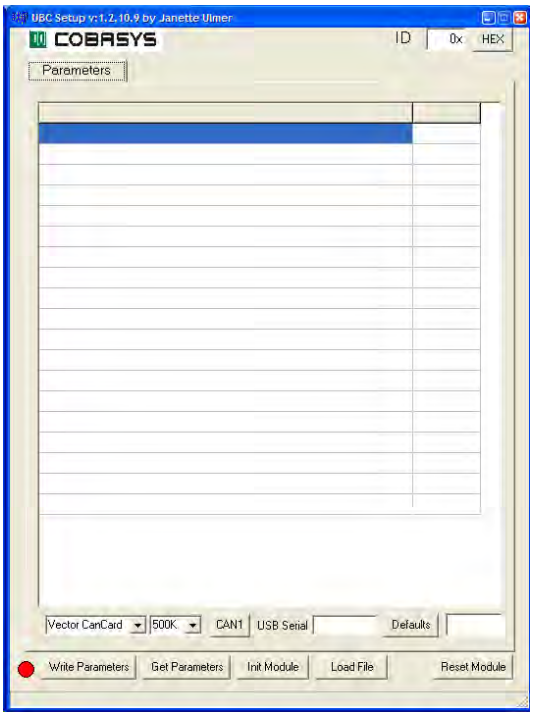


Figure 52

   - Load Calibration Files
     - Turn on the pack by either:
     - If pack is attached to a vehicle: Turn the vehicle ignition key to the –ON" position. DO NOT enable the high voltage system by turning the ignition to the –START" position.
     - If pack is attached to a programming adapter harness: Set the –OFF / ON" switch to –ON", then set the –KEY ON / KEY OFF" switch to –KEY ON"
   - Select and load the following calibration parameter .prm files, in sequence:
     - BattCalParams.prm
     - RpCalParams.prm
     - The appropriate file for the Azure-specific configuration parameters for the target application (ex. CalParams_Azure_336_500k.prm or CalParams_Azure_288_500k.prm)
   - For each file:
     - In the calibration loader application click –Load File".
     - Select the correct file". See Figure 16.
     - Click –Open".
     - Click –Write Parameters".
     - Wait for programming to complete—a message will appear in the bottom message box indicating –CBCM has accepted the new parameters". See figure 17.
     - **<u>IMPORTANT:</u> If the message box says "No Response from CBCM" the calibration has NOT been successful and must be reattempted.**

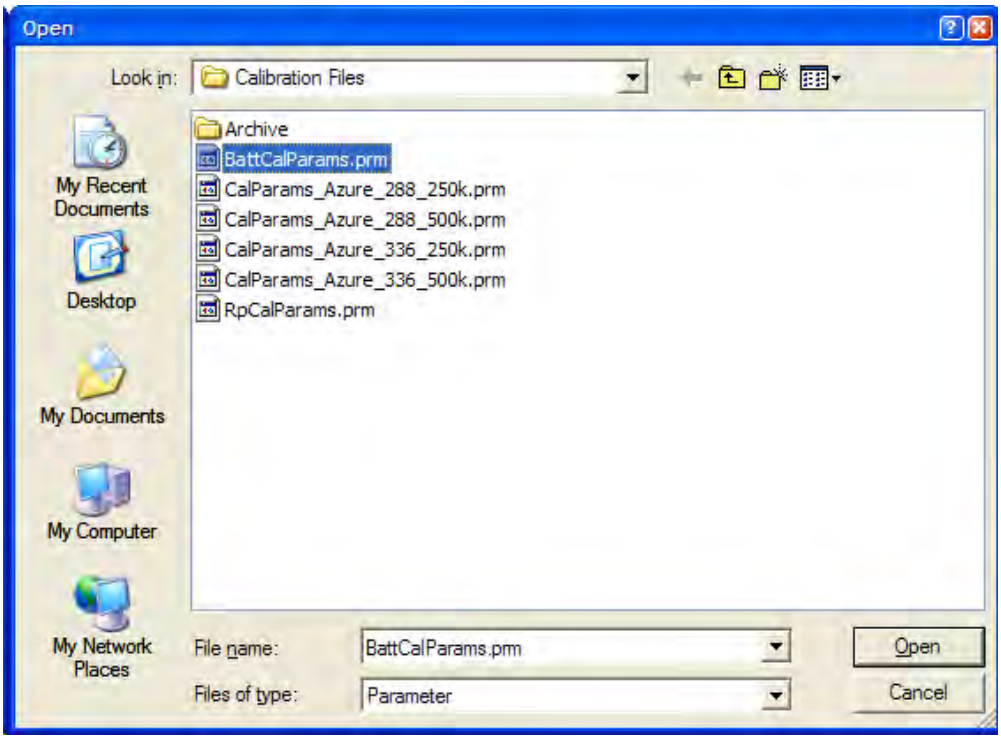


Figure 53

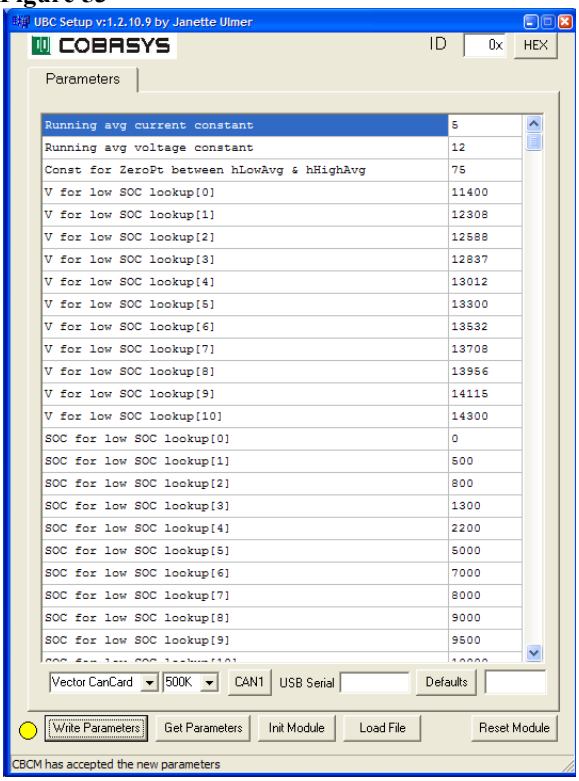

UBC Setup v:1.2.10.9 by Janette Ulmer
COBASYS
ID
0x
HEX
Parameters
Running avg current constant 5
Running avg voltage constant 12
Const for ZeroPt between hLowAvg & hHighAvg 75
V for low SOC lookup[0] 11400
V for low SOC lookup[1] 12308
V for low SOC lookup[2] 12588
V for low SOC lookup[3] 12837
V for low SOC lookup[4] 13012
V for low SOC lookup[5] 13300
V for low SOC lookup[6] 13532
V for low SOC lookup[7] 13708
V for low SOC lookup[8] 13956
V for low SOC lookup[9] 14115
V for low SOC lookup[10] 14300
SOC for low SOC lookup[0] 0
SOC for low SOC lookup[1] 500
SOC for low SOC lookup[2] 800
SOC for low SOC lookup[3] 1300
SOC for low SOC lookup[4] 2200
SOC for low SOC lookup[5] 5000
SOC for low SOC lookup[6] 7000
SOC for low SOC lookup[7] 8000
SOC for low SOC lookup[8] 9000
SOC for low SOC lookup[9] 9500
Vector CanCard
500K
CAN1
USB Serial
Defaults
Write Parameters
Get Parameters
Init Module
Load File
Reset Module
CBCM has accepted the new parameters

Figure 54

5. **Disconnect Programming Hardware**

- Disconnect the serial cable, laptop CAN hardware interface and programming adapter harness (if being used).

6. **Update Code Version Label on Battery Pack**

- If there is no software version label on the battery pack, or version on the label is different from that listed on the BOM and that just loaded, make a new label identifying the new S/W code. Use blank label 100996 and worded ~~–S~~/W Ver X.X.X.".
- Apply label to battery pack, covering old label. Label is typically located just above the supplier's label.